AD-A168 672 TEST AND EVALUATION OF CLEATED CORRUGATED PLASTIC CONTAINERS(U) AIR FORCE PACKAGING EVALUATION AGENCY WRIGHT-PATTERSON AFB OH P QUIJAS 23 MAY 86 1/1

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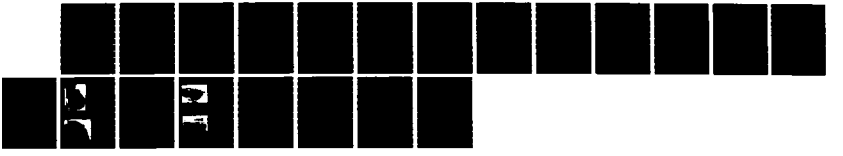

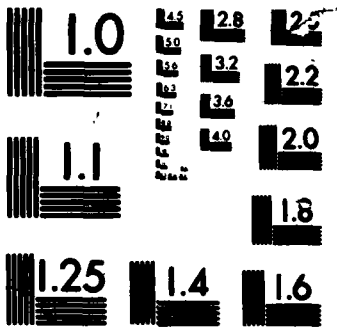

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AFPEA REPORT NO. 86-R-04
AFPEA PROJECT NO. 84-P-101
AD NO.

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TEST AND EVALUATION OF CLEATED CORRUGATED PLASTIC CONTAINERS

HQ AFLC/DSTZ
AIR FORCE PACKAGING EVALUATION AGENCY
Wright-Patterson AFB OH 45433-5999

May 1986

NOTICE

AFPEA PROJECT NO: 84-P-101

TITLE: Test and Evaluation of Cleated Corrugated Plastic Containers

ABSTRACT

At the request of the San Antonio Air Logistics Center (SA-ALC), the Air Force Packaging Evaluation Agency (AFPEA) conducted testing and evaluation of a new concept for substituting a corrugated plastic material for plywood in containers otherwise constructed in accordance with Federal Specification PPP-B-601. The purpose of the new cleated plastic container concept was to provide a cost-effective Level A shipping container to replace/upgrade Level B shipping containers instead of present practice of replacing with heavier cleated plywood containers. With slight modification, the new container's performance exceeded all expectations by fulfilling the primary purpose as well as exhibiting capabilities for replacing cleated plywood containers from which they were patterned.

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21 MAY 1986

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

INTRODUCTION

Background: San Antonio Air Logistics Center/DSTD, Kelly AF Base, Texas, requested assistance from the Air Force Packaging Evaluation Agency (AFPEA), Wright-Patterson AFB, Ohio, to investigate, evaluate, and test containers constructed similar to Federal specification PPP-B-601, "Boxes, Wood, Cleated-Plywood," except that a corrugated plastic sheet material was to be substituted in place of the plywood sheet material. It was desired also that the container have an easily removable lid to enhance container reuseability and that the new concept should, if found adequate, enable upgrading to Level A of most all the fiberboard packaging presently limited to Level B shipment. Estimated savings in the cost of materials by SA-ALC in the first year would exceed $61,000. Additional savings due to a lighter container would be lower shipping costs of $185,000 for a total estimated $246,000 savings per year.

Purpose: The purpose of this project was to:

a. Investigate and evaluate the concept for use in Level A protection instead of wood-plywood containers presently used to replace fiberboard containers which are limited to Level B protection.

b. Test and evaluate design and make changes to improve performance as required.

c. Compile design and engineering data for use by SA-ALC and the Air Force.

TEST SPECIMENS

Originally, three container designs were submitted for evaluation by SA-ALC. The designs all incorporated features from the PPP-B-601 container specification. The designs were called, the Body Top, the Cap Top, and the Inner-Cleated Top design. A brief description and evaluation on each one is as follows:

a. Body Top. This design was basically a MIL-B-26195 container which has a skidded base covered by an assembled cleated panel box which body can be removed as a top by removal of lag screws from around the base. This design was deemed too complex, heavy, and costly for the purpose of this project and was not considered further.

b. Cap Top. This design (see Figure 1) consisted of a cleated panel box body which had the panel material extending a

few inches above the upper cleats to allow reception of a cap-like cleated panel. The cap and container body were bound into a unit with metal bands only. In preliminary free-fall drop testing, it was found that the cap was very vulnerable to damage (cracking, splitting, nail withdrawal) due to poor shear strength around the cap. Because of the specialized cap construction, its marginal performance in testing, and diminished reuseability, this design was abandoned.

c. Inner-Cleated Top. This design was basically a cleated panel construction in accordance with PPP-B-601. It consisted of an assembled body with a removable (unnailed) cleated panel top. The top or lid had cleats added on the inner face to fit snugly into the container opening to prevent longitudinal and lateral movement of the lid when closed. Closure of the lid on the body was effected using metal bands only. This type of unnailed closure, at the request of AFPEA, was tested and approved for use by the Army in Amendment 2, 29 March 1985 of PPP-B-601G. Containers initially submitted for testing exhibited several deviations from the fabrication requirements of the specification and were rejected. Deviations included such things as overdriven staples which resulted in broken crowns and crushing of the plastic; improper spacing and edge distance of staples in panel assemblies; and improper nail treatment, size and spacing in the assembly of adjacent panels. New containers properly fabricated were subjected to testing. Failures of this design occurred during initial testing mainly due to end panel failure such as shown in Figure 2. However, after determination of the weak points in the end panel of the box structure, and through correction/ strengthening of the condition by addition of an inner through-cleat at the upper edge of the end panel (see Figure 3), the failure problems were eliminated. This design was then pursued because of simplicity, its construction identical to existing specification PPP-B-601 (except for plastic instead of plywood sheeting), and its reuseability as well as lightweightness, waterproofness and cost-effectiveness.

Improved inner-cleated top container prototypes with added inner cleat at the top of each end panel were submitted by SA-ALC for test and evaluation. The specimens were constructed in accordance with PPP-B-601G, Amendment 2, Style A, unnailed closure (see Figure 3), using staples in assembly of panels. Instead of plywood, a plastic material was substituted conforming to MIL-P-83668 (USAF), "Plastic Board (For Packaging Application)," Type II which is a laminated corrugated construction. The board used was of polyethylene material having a basis weight of 245 to 255 pounds per 1000 square feet (lb/MSF). The board also contained 1/2 percent of an ultra-violet light inhibitor. Of several colors available, a light blue color was used. Contents for testing were Type 3 (difficult) loads (see Figure 1) consisting of metal pipe sections 2 7/8" diameter x 3" long and some small cartoned loads

and lead-weighted laminated-plywood blocks of various sizes to make up the required weight. Closure of the top onto the container was effected per PPP-B-601 using steel banding only (no nailing or stapling). Sizes of the container specimens were one each 34" x 20" x 18" (small container) and one each 42" x 29" x 30" (large container) with skids. The net load used in the small container was 150 pounds and gross weight was 175 pounds. The large container net load used was 400 pounds and gross weight was 456 pounds.

TEST OUTLINE AND TEST EQUIPMENT

Tests were conducted in accordance with the AFPEA container test plans project number 84-P-101, Rev 1, 1-19-84, shown in Table I for the small container and Table II for the large container. Test methods and procedures used were as specified in MIL-STD-794E, Appendix C, para 10.5 and Federal Test Method No. 101C (FTMS No. 101C). Equipment used in testing was as follows:

a. Drop Test Hoist, Quick Release and other devices.

b. Pendulum-Impact Apparatus.

c. Testing Machines Inc. (TMI), Compression Tester, Model No. 17-24-2, 50,000 pound capacity.

d. Vibration Machine, L.A.B. Corporation, Serial No. 56801, Type 5000-96B.

e. Steel plate and lead weight.

f. Forklift, 2000 pound capacity.

TEST PROCEDURE AND RESULTS

A. Small container tests (see Table I).

Test No. 1: Inspection. The small container as received was visually inspected for conformance to requirements.

Results: The small container (34 x 20 x 18) was constructed in accordance with style A, unnailed closure of PPP-B-601G, Amendment 2 using the plastic board instead of plywood. The cleats were 3/4 inch thick and minimum 2 inches wide. For testing, the container carried a type 3 (difficult) contents load of 150 pounds.

Test No. 2: Free-Fall Drop Test. The test was conducted on the small container in accordance with FTMS No. 101C, Method 5007,

Procedure B and E and MIL-STD-794E, Appendix C, para 10.5. Height of the drop was 18 inches.

Results: During drop number 9, cleat number 1-5 of the bottom panel developed a nonserious crack along 3 nails used in container assembly. On the 14th and final drop, side edge numbered 6-7 showed a separation of 1/4 inch from the adjacent panel edge. Test result was acceptable.

Test No. 3: Vibration (Repetitive Shock) Test. The test was conducted in accordance with FTMS No. 101C, Method 5019.1. The container was placed on an L.A.B. Corporation vibration machine but was not fastened to the platform. Blocks were placed on four sides with about 1/2 inch clearance to allow free movement of the container while keeping it centered on the platform during the two-hour test period. The platform was vibrated so as to raise the container from the platform (1/6 inch feeler gauge clearance between bottom of container and platform) to effect a maximum acceleration of 1G.

Result: Visual inspection revealed no damage to the container from this test. The result of the test was acceptable.

Test No. 4: Superimposed Load Test (Stackability with Dunnage. This test was additional to the MIL-STD-794E requirements for small containers, but was performed to ascertain the ability of the cleated plastic board to withstand stacking loads. The test was conducted in accordance with FTMS No. 101C, Method 5016.1. The container was placed on the TMI compression tester and subjected to a 2700 pound load for one hour.

Results: An average deflection of approximately 0.1 inch was measured without any damage to the container noted. Test result was acceptable.

B. Large container tests (see Table II)

Test No. 1: Inspection. The large container as received was examined for conformance to requirements.

Results: The large container (42x29x30) was constructed in accordance with style A, unnailed closure of PPP-B-601G, Amendment 2 using the plastic board instead of plywood. The cleats were 3/4 inch thick and approximately 3 inches wide. For testing, the container carried a type 3 (difficult) contents load of 400 pounds. An incorrect 6 inch spacing of nails joining adjacent container panels was found and was corrected to the required 4" spacing.

Test No. 2: Edgewise-Drop (Rotational) Test. The test was conducted on the large container in accordance with FTMS No.

101C, Method 5008.1 and MIL-STD-794E, Appendix C, para 10.5. Height of the drop was 28 inches.

Results: On edgewise drop number 2 which was on an end, a 7 inch split or tear (without opening) occurred in the plastic board parallel to the flutes with no danger of failure. This was caused by impingement against the plastic of a corner of one of the laminated plywood blocks in the load. In subsequent drop numbers 3 and 4 which were on the sides, the side panels tended to separate from the end panels just below the top panel locally at two upper opposite corners with gaps of 1 inch and 2 inches. There was no spillage of contents and the container remained intact. Result was acceptable.

Test No. 3: Cornerwise-Drop (Rotational) Test. The test was in accordance with FTMS No. 101C, Method 5005.1 and MIL-STD-794E, Appendix C, para 10.5 for a large container. Height of the drop was 28 inches.

Results: On the first cornerwise drop, a 2" split or tear (without opening) occurred just off center in the plastic parallel to the flutes. This 2 inch split was in the same end but was about a foot from a 7 inch split caused by the preceding edgewise drop test. A corner of the same laminated plywood block in the contents is believed to have caused both splits. On the 4th and final cornerwise drop there was a slight separation noted of the bottom cleat from the end panel. The container remained intact and there was no spillage of contents. Test results were acceptable.

Test No. 4: Pendulum-Impact Test. The test was conducted in accordance with FTMS No. 101C, Method 5012 on each of four faces at an impact velocity of 7 feet per second.

Results: As a result of the impacts, there was a small cut (not a hole) in the plastic panel of one side. Also, one of the longitudinal steel bands shifted to the edge along the top but did not slip off. Results were acceptable.

Test No. 5: Superimposed-Load Test (Stackability with Dunnage. The test was conducted in accordance with FTMS No. 101C, Method 5015.1. The container was placed on the TMI compression tester and subjected to a 4,975 pound load for one hour.

Result: The total deflection measured was 0.374 inches without any damage to the container. Test result was acceptable.

Test No. 6: Superimposed-Load Test (Uniformly Distributed, without Dunnage. The test was performed in accordance with FTMS [illegible] Method [illegible]. A total uniformly distributed load of

848 pounds consisting of 8 unit loads of 106 pounds each was placed on each square foot of the container top for one hour.

Result: No adverse affect was noted from this test. Test result was acceptable.

Test No. 7. Vibration (Repetitive Shock) Test. The test was conducted in accordance with FTMS No. 101C, Method 5019.1. The container was placed on an L.A.B. Corporation vibration machine but was not fastened to the platform. Blocks were placed fore and aft with about 1/2 inch clearance to allow free movement of the container while keeping it centered on the platform during the 2-hour test period. The platform was vibrated so as to raise the container from the platform (1/16 inch feeler gauge clearance between bottom of container and platform) to effect a maximum acceleration of 1G.

Results: Externally, the container appeared in good shape without any change. Internally, the bottom plastic board showed only superficial abrasion from the metal (pipe) cylinders which covered the bottom as part of the contents. Test results were acceptable.

C. Field service test of small and large containers. A field service test was set up between San Antonio ALC and Sacramento ALC for round trip shipments of the cleated corrugated polyethylene plastic containers by surface and by air to determine their performance in actual handling and shipment.

The service test began in November 1984 with the shipment of two small containers (34"x20"x18") shown in Figure 4 of which one was cleated plastic and the other cleated plywood. The containers were each carrying a 150 pound type 3 (difficult) load consisting of angle iron and other varied loose metal objects. The service test was terminated in December 1985 after completion of 17 round trips. In general, very little maintenance was required during the entire service test for such things as loosened cleats, loose bands and one missing band.

Service testing of the large containers (44"x31"x24") shown in Figure 5 began on 22 Apr 85 with the shipment of six each large cleated plastic containers consisting of one pair of containers each carrying a type 3 contents load of 300 pounds, a second pair each carrying 400 pounds and the third pair each carrying 500 pounds. Contents were similar to that described for the small containers. The service test for the large containers was terminated in December 1985 when the containers had completed 10 round trips. In general, minor maintenance and repairs on the containers were sometimes necessary in instances involving an occasional loosened cleat, loosened, broken or missing banding,

a minor split (no hole) in the plastic panel of 2 different boxes, and a missing skid in two instances.

CONCLUSION

It is concluded that the cleated corrugated polyethylene plastic panel containers can be implemented safely and economically to replace all Level B fiberboard container shipments for upgrading to Level A. Payloads as high as 500 pounds can be transported in these cleated panel containers when constructed in accordance with PPP-B-601G, Amendment 2, Style A or B, Unmanned Closure (see Figure 3) using clinched staples in panel assembly with adjacent panels assembled and closure effected (banding only) as specified in the referenced specification.

It is further concluded that based on the test procedures used and to the extent of the 500 pound loads tested, that these cleated plastic containers using a 245 to 255 lb/MSF basis weight board can replace cleated plywood containers on an equivalent basis. Because corrugated polyethylene board material is available in various basis weights up to 550 lb/MSF, it is believed that through a development testing program, plastic board(s) of appropriate strength can be determined which may be capable of replacing plywood up to the 1000 pound contents range established in PPP-B-601.

RECOMMENDATIONS

For effective implementation, it is recommended that requirements be incorporated in PPP-B-601 to provide for substitution of corrugated polyethylene plastic sheeting for plywood. Recognizing that this action would involve changes in the specification title and weight limits to accommodate the cleated plastic containers thus far tested, it would however avoid a proliferation of specifications. This allows implementation and use without requiring changes to the numerous drawings, SPIs, and other specifications that currently specify PPP-B-601. It is further envisioned that the cleated plastic containers could be substituted for those specified in:

a. PPP-B-591, Boxes, Shipping, Fiberboard, Wood-Cleated

b. PPP-B-576, Boxes, Wood, Cleated, Veneer, Paper Overlaid

TABLE I

AIR FORCE PACKAGING EVALUATION AGENCY (Container Test Plan) Tare: 25					AFPEA PROJECT NUMBER 84-P-101, Rev 1	
CONTAINER SIZE (L X W X D)(INCHES) INTERIOR:	EXTERIOR: *	WEIGHT (LBS) GROSS:	ITEM:	CUBE (CU. FT.)	QUANTITY	DATE
32x18x16	34x20x18	175	150	7.08	1	1-19-84

ITEM NAME	MANUFACTURER
Simulated Type 3 Load	SA-ALC/DSTD

CONTAINER NAME	CONTAINER COST
Cleated Corrugated Plastic Box (Inner-Cleated	Top)

PACK DESCRIPTION: Level "A" Cleated Panel Construction Per PPP-B-601, Style A, with Modification

CONDITIONING: NOTE: Ambient Testing is per MIL-STD-794E, Appendix C, para 10.5, or as noted herein.

TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO's	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRUMENTATION
1.	INSPECTION	Examination of product. Check physical data, dimensions, weight, etc., as received.	N/A	As Required
2.	FREE-FALL DROP TEST FTMS 101C Method 5007 Proc. E Flat drop Proc. B Corner drop	Drop height of 18 inches Sequence of corner and flat drops. Drop No. 1 Corner 1 2 2 3 Bottom 4 Top 5 3 6 4 7 Side A 8 Side B 9 5 10 6 11 Side C 12 Side D 13 7 14 8	Mark IAW MIL-STD-794E, Figure 1 for drop test.	N/A
3.	VIBRATION (REPETITIVE SHOCK) TEST FTMS 101C Method 5019.1	1" D.A. and 3-5 Hz for 2 hours.	Normal Position	N/A
** 4.	SUPERIMPOSED LOAD TEST (STACKABILITY WITH DUNNAGE) FTMS 101C Method 5016.1	Load to be 2700 lbs for 1 hour.	Normal Position	N/A

COMMENTS: *Approximates standard size of 32"Lx20"Wx20"H, Cube: 7.41
** This test is additional to MIL-STD-794E requirements for small containers.

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TABLE I

PAGE 1 OF 1

TABLE II

AIR FORCE PACKAGING EVALUATION AGENCY (Container Test Plan) Tare: 56.0					AFPEA PROJECT NUMBER 84-P-101, Rev 1	
CONTAINER SIZE (L X W X D)(INCHES) INTERIOR:	EXTERIOR: #	WEIGHT (LBS) GROSS:	ITEM:	CUBE (CU. FT.)	QUANTITY	DATE
40x27x28	42x29x30	456	400	21.14	1	1-19-84

ITEM NAME	MANUFACTURER
Simulated Type 3 Load	SA-ALC/DSTD

CONTAINER NAME	CONTAINER COST
Cleated Corrugated Plastic Box (Inner-Cleated Top)	

PACK DESCRIPTION

Level "A" Cleated Panel Construction Per PPP-B-601, Style A, with Modification

CONDITIONING

NOTE: Ambient Testing is per MIL-STD-794E, Appendix C, para 10.5

TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO's	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRUMENTATION
1.	INSPECTION	Examination of product. Check physical data, dimensions, weight, etc., as received.	N/A	As Required
2.	EDGEWISE-DROP (ROTATIONAL) TEST FTMS 101C Method 5008.1	Drop once on each edge of container base. Height of drop for 460 lbs is 28 inches.	Mark box IAW MIL-STD-794E, Fig 1 for testing. 6" support 1 edge, drop opposite edge.	N/A
3.	CORNERWISE DROP (ROTATIONAL) TEST FTMS 101C Method 5005.1	Drop once on each corner of container base. Height of drop for 460 lbs is 28 inches.	Corners of 1 end on 6" & 12" supports, drop corner of other end.	N/A
4.	PENDULUM-IMPACT TEST FTMS 101C Method 5012	Impact end and side (4 faces) at 7 fps (9" vert. drop).	Impact 1 end, then opposite end. Impact 1 side, then opposite side.	N/A
5.	SUPERIMPOSED-LOAD TEST (STACKABILITY WITH DUNNAGE) FTMS 101C Method 5016.1	Load on 456 lb box to be 4925 lbs for 1 hour	Normal position	N/A
6.	SUPERIMPOSED-LOAD TEST (UNIFORMLY DISTRIBUTED, WITHOUT DUNNAGE FTMS 101C Method 5017	Load on 456 lb box to be 8 unit 10"x10" at 106 lb each.	Normal position	N/A
7.	VIBRATION (REPETITIVE SHOCK) TEST FTMS 101C Method 5019.1	1" D.A. and 3-5 Hz for 2 hours	Normal position	

COMMENTS: *Approximates standard test size of 44"Lx31"Wx24"H, Cube: 13.94

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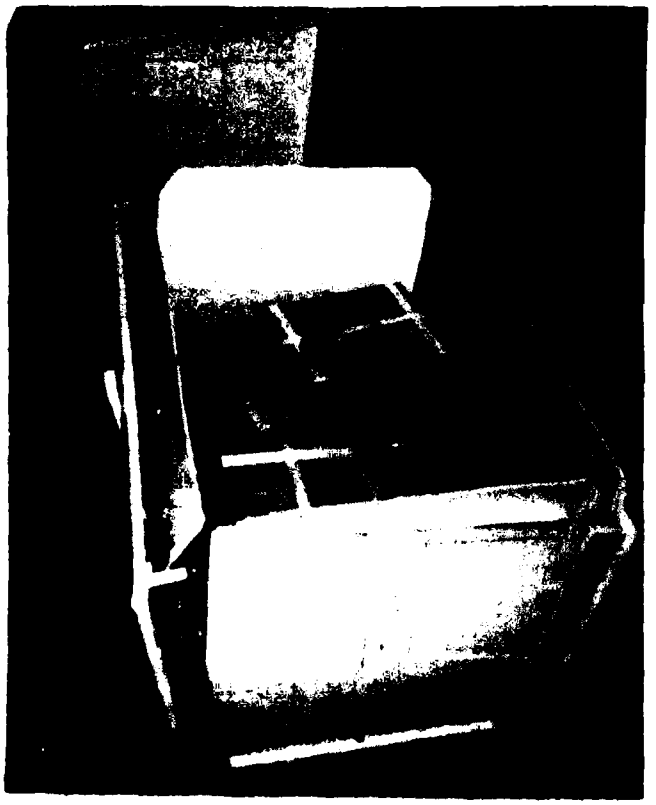


Figure 1, A Cap Top design container is shown carrying a typical Type 3 (difficult) load used in small and large test containers.

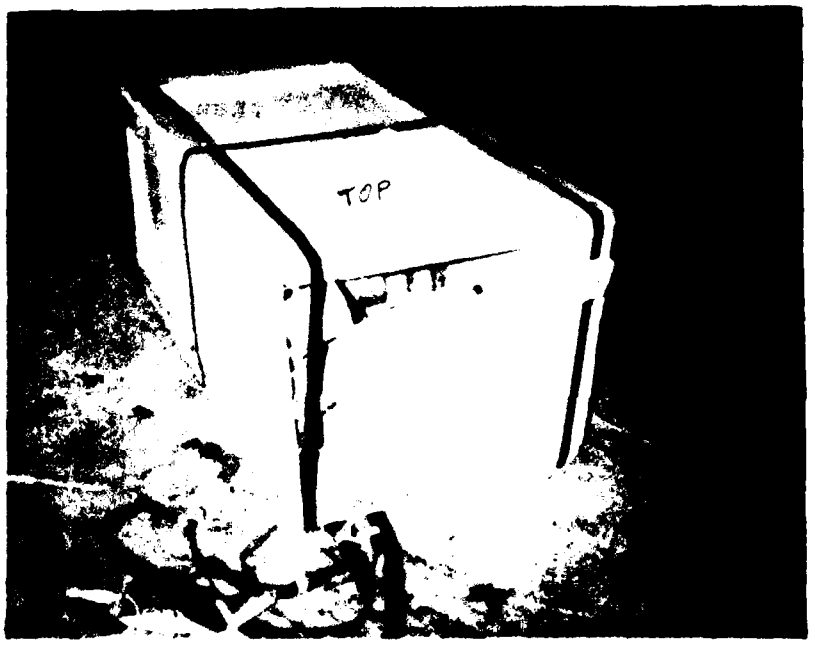
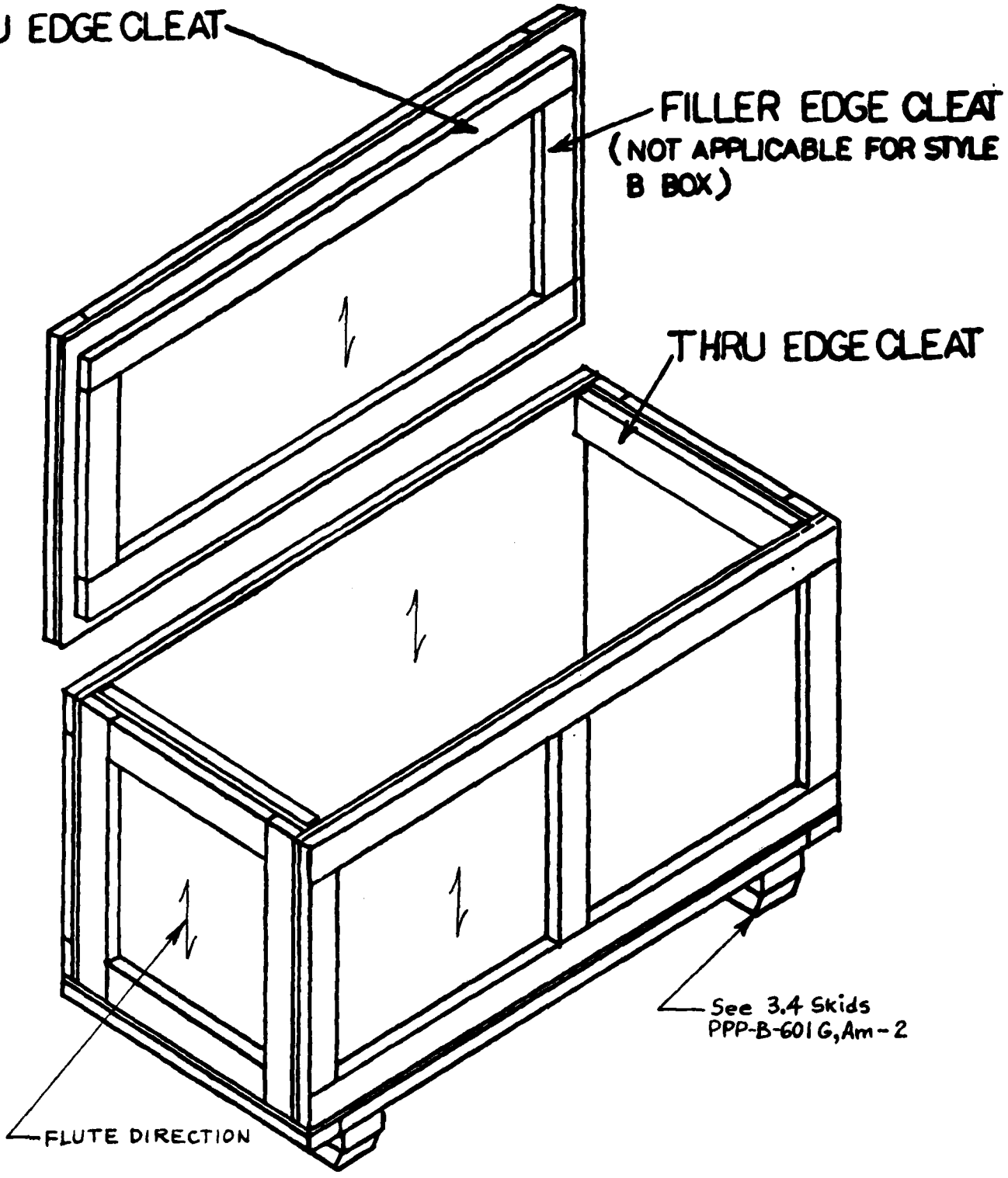


Figure 2, Typical end panel failure of small containers (Inner-Cleated Top design shown) during free-fall drop test prior to correction of weak points.



TOP & END PANEL MODIFICATION OF UNNAILED CLOSURE, STYLE A, CLEATED PLASTIC BOX

FIGURE 3

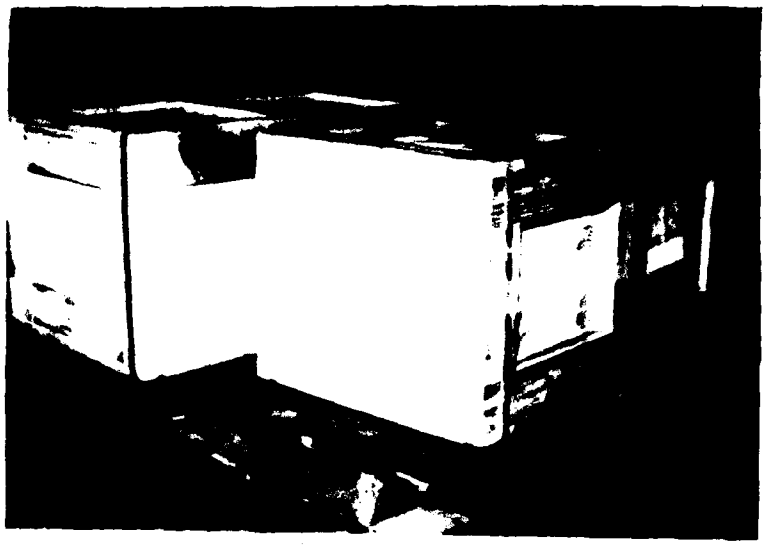


Figure 4, Small (34"x20"x18") containers used in the Field Service Test. Each container carried a 150 pound Type 3 load for 17 air-truck round trips and was still reusable.

Figure 5, Large (42"x29"x30") containers used in the Field Service Test. Each container of 3 pairs carried 300, 400, and 500 pound Type 3 loads for 10 air-truck round trips and was still reusable.

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

At the request of the San Antonio Air Logistics Center (SA-ALC), the Air Force Packaging Evaluation Agency (AFPEA) conducted testing and evaluation of a new concept for substituting a corrugated plastic material for plywood in containers otherwise constructed in accordance with Federal Specification PPP-B-601. The purpose of the new cleated plastic container concept was to provide a cost-effective Level A shipping container to replace/upgrade Level B shipping containers instead of present practice of replacing with heavier cleated plywood containers. With slight modification, the new container's performance exceeded all expectations by fulfilling the primary purpose as well as exhibiting capabilities for repacing cleated plywood containers from which they were patterned.

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